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INTRODUCTION

In this aritcle the writer deals with the foraminiferal faunas derived from the Miocene Bihoku group distributed in the Funo and Saijō basins in Hiroshima Prefecture, West Japan.

Previously the writer dealt with many smaller Foraminifera from geographically isolated Miocene areas in Hiroshima Prefecture (Tai, 1953, 1957, 1959). With regard to the newly obtained smaller Foraminifera from five foraminiferal samples of the following two localities some remarks are added and the significance of them is discussed. Of five samples, four (1–4) were collected by the writer from a shale facies of the Bihoku group, along the Funo River in Kamifuno, Funo-mura, Futami-gun, and the remaining one (5) from a shale facies of the same group, exposed at Oya, Saijō-machi, Hiba-gun, Hiroshima Prefecture (Fig. 1).

According to the stratigraphical works of S. Imamura (1950, 1953) and the writer (1950), these shale facies which yielded the smaller Foraminifera correspond to the Upper

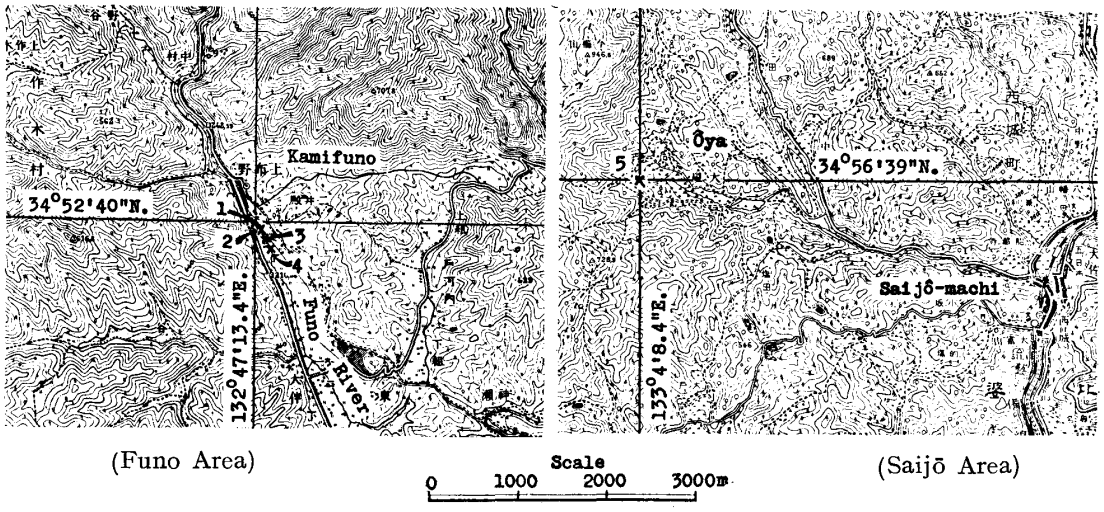

Fig. 1 Map showing the sampling localities.

Table 1. Distribution of Funo and Saijô Foraminifera

Species \ Loc. no.	FUNO				SAIJO
	1	2	3	4	5
Bathysiphon sp.	F	F	F	–	–
Haplophragmoides compressum LeRoy	–	–	–	–	R
Haplophragmoides sp.	–	R	–	–	–
Gaudryina ishikiensis Asano	R	F	–	F	A
Plectina sp.	–	R	–	–	–
Goësella schencki Asano	–	–	–	–	R
Goësella sp.	–	R	–	–	–
Martinottiella communis (d'Orbigny)	R	F	C	–	–
Sigmoilina imamurai Tai	F	F	–	–	–
Trochammina sp.	R	R	–	R	R
Robulus iotus (Cushman)	–	F	–	R	–
Robulus cf. *iotus* (Cushman)	–	–	–	–	F
Robulus lucidus (Cushman)	R	A	R	A	A
Robulus nikobarensis (Schwager)	–	–	–	–	C
Robulus cf. *nikobarensis* (Schwager)	–	C	–	–	C
Robulus pseudorotulatus Asano	–	–	–	–	F
Robulus sp.	A	A	C	A	C
Marginulina aculeata Neugeboren	–	–	–	–	R
Marginulina masudai Asano	–	–	–	–	R
Marginulina mukaei Tai and Okamoto	–	–	–	–	F
Dentalina emaciata Reuss	–	F	–	–	–
Dentalina insecta (Schwager)	R	C	–	A	R
Dentalina soluta Asano	–	–	–	–	F
Dentalina cf. *soluta* Asano	–	F	–	–	–
Dentalina tauricornis (Schwager)	–	R	–	–	–
Dentalina sp.	F	R	R	–	F
Nodosaria notoensis Asano	F	–	–	–	R
Nodosaria pyrula d'Orbigny	–	R	–	–	–
Pseudoglandulina laevigata (d'Orbigny)	–	–	–	–	R
Lagenonodosaria fukushimaensis Asano	–	R	–	–	C
Lagenonodosaria scalaris (Batsch)	F	F	R	R	C
Saracenaria sp.	–	R	–	–	–
Vaginulina bradyi Cushman	–	A	F	–	–
Lagena sp.	–	R	R	R	–
Guttulina cf. *asanoi* Iwasa and Kikuchi	–	–	–	–	R
Guttulina irregularis (d'Orbigny)	–	–	–	–	F
Guttulina cf. *irregularis* (d'Orbigny)	–	R	–	–	–
Guttulina sp.	–	–	–	R	–
Globulina sp.	–	–	–	R	–
Nonion grateloupi (d'Orbigny)	–	–	–	–	F
Nonion japonicum Asano	–	R	–	R	F
Nonion kidoharaense Fukuda	–	–	–	–	F
Nonion nakosoense Asano	–	–	–	R	R
Nonionella miocenica Cushman	–	–	–	R	R
Elphidiella momiyamaensis Uchio	–	–	–	–	R
Bulimina striata d'Orbigny	–	–	–	–	R
Bulimina striata notoensis Asano	–	–	–	–	R
Bolivina marginata Cushman	–	R	–	–	R
Bolivina marginata masudai Asano	–	–	–	–	R
Uvigerina crassicostata ? Schwager	–	–	–	–	R
Uvigerina cf. *nitidula* Schwager	–	–	–	–	R
Angulogerina kokozuraensis Asano	–	R	–	–	–
Ellipsonodosaria lepidula (Schwager)	–	C	F	–	A
Gyroidina soldanii d'Orbigny	–	–	–	–	R
Eponides frigidus (Cushman)	–	F	–	–	F

Continued

Eponides praecinctus (Karrer)	–	C	–	–	A
Eponides cf. *praecinctus* (Karrer)	–	–	R	C	–
Eponides subpraecinctus Asano	–	–	–	–	R
Eponides umbonatus (Reuss)	–	F	–	–	R
Eponides sp.	–	–	F	–	R
Rotalia cf. *beccarii* (Linnaeus)	–	–	–	R	R
Rotalia inflata (Seguenza)	–	R	–	–	R
Rotalia takanabensis (Ishizaki)	–	R	–	R	F
Baggina notoensis Asano	–	–	–	–	R
Epistominella sp.	R	–	–	–	R
Cassidulina laevigata carinata Cushman	–	R	–	–	–
Cassidulina subglobosa Brady	–	R	–	–	–
Globigerina sp.	–	R	–	–	A
Globorotalia sp.	–	–	–	–	R
Anomalina kojimaensis Tai	–	–	–	–	R
Planulina cf. *asanoi* Tai	–	–	–	–	F
Planulina nipponica Asano	–	–	–	–	R
Hanzawaia cf. *nipponica* Asano	–	–	–	–	R
Hanzawaia tagaensis Asano	–	R	–	A	A
Cibicides lobatulus (Walker and Jacob)	R	R	–	–	R
Cibicides pseudoungerianus (Cushman)	C	C	C	–	F
Cibicidss cf. *shukuensis* Tai	–	–	–	–	R

A ; Abundant, C ; Common, F ; Few, R ; Rare

Shale member conformably superposed on the Lower Sandstone member, the lower part of the Bihoku group, which has yielded a number of important fossils, such as *Miogypsina kotoi* Hanzawa, *Operculina complanata japonica* Hanzawa, *Batillaria yamanarii* Makiyama, *Vicarya callosa* Jenkins, *Siratoria siratoriensis* (Otuka), and *Soletellina minoensis* Yokoyama, etc.

FAUNAL CONSIDERATION

The foraminiferal fauna from the upper Bihoku group of both the Funo and Saijō localities consists of 77 species and subspecies (Table 1) belonging to 39 genera and 16 families. The family Lagenidae is represented by the largest number of genera, species, and individuals. Of the other families, those of the Nonionidae, Buliminidae, Rotaliidae, and Anomalinidae are next in abundance.

As shown in Table 1, the difference between the Funo and Saijō assemblages is slight and probably negligible, but the former differs from the latter in lacking a few species of the families Buliminidae and Anomalinidae. The genera *Gaudryina*, *Robulus*, *Dentalina*, *Lagenonodosaria*, *Ellipsonodosaria*, *Eponides*, *Rotalia*, *Hanzawaia*, and *Cibicides* contain the majority of the species and individuals in both assemblages mentioned above.

The depth analysis of these common genera indicates that the shale facies was deposited in depths corresponding to the mid- to outer-neritic zone. This statement is upheld by the extremely rare occurrence of the family Miliolidae and the absence of the genus *Elphidium* in the present fauna are evidence that it is not a littoral assemblage. Furthermore, that the fauna is characterized with a large number of species of *Robulus* and its allied genera, which indicates a neritic environment and probably its outer part.

From a comparison between the Funo and Saijō assemblages, the shale facies with

the former assemblage seems to have been deposited at a depth slightly shallower than that of the latter.

CORRELATION

The microfauna of the upper Bihoku group is very similar to those of the middle Miocene formations of West Japan, especially in the Chūgoku District, already reported by the writer during the years 1953–1959.

Further, of the 62 species discriminated among the present fauna, 46 occur in the fauna reported by K. Asano (1953) from the upper part of the middle Miocene Higashi-Innai formation in the Noto Peninsula, Ishikawa Prefecture. The percedtage of common species between the present and Noto faunas is about 74. This large percentage is considered to indicate a surprising similarity in the conditions of deposition and environments of the foraminiferal faunas of the two geographically separated middle Miocene areas. According to K. Masuda (1954), the middle part of the Higashi-Innai formation also contains abundant specimens of larger Foraminifera and important megafossils, such as *Miogypsina kotoi* Hanzawa, *Operculina complanata japonica* Hanzawa, *Batillaria yamanarii* Makiyama, *Vicarya callosa japonica* Yabe and Hatai, *Vicaryella* cfr. *ishiiana* (Yokoyama), and *Soletellina minoensis* Yokoyama, etc.

From the foregoing remarks, the Bihoku group here can be correlated with the middle and upper parts of the Higashi-Innai formation. This conclusion is the same as previously reported by the writer in his study of the Tsuyama Miocene Foraminifera (Tai, 1954).

The present fauna also is similar to those of the Indo-Pacific Miocene regions, such as Sumatra (L. W. LeRoy, 1941, 1944), Java (L.W. LeRoy, (1944), Borneo (L.W. LeRoy, 1914), Kar Nicobar Islands (C. Schwager, 1866), Fiji Islands (J.A. Cushman, 1934), and Saipan (R. Todd, 1957). Of the determined species in the present fauna, the following 20 occur from these Miocene areas just mentioned: *Bolivina marginata* Cushman, *Bulimina striata* d'Orbigny, *Cassidulina subglobosa* Brady, *Cibicides lobatulus* (Walker and Jacob), *Cibicides pseudoungerianus* (Cushman), *Dentalina insecta* (Schwager), *Dentalina tauricornis* (Schwager), *Ellipsonodosaria lepidula* (Schwager), *Eponides praecinctus* (Karrer), *Eponides umbonatus* (Reuss), *Gyroidina soldanii* (d'Orbigny), *Lagenonodosaria scalaris* (Batsch), *Nodosaria pyrula* D'Orbigny, *Nonion grateloupi* (d'Orbigny), *Pseudoglandulina laevigata* (d'Orbigny), *Robulus iotus* (Cushman), *Robulus lucidus* (Cushman), *Robulus nikobarensis* (Schwager), *Uvigerina nitidula* Schwager, and *Vaginulina bradyi* Cushman.

Compared with the time-rock units established by the writer (Tai, 1959) based upon the Miocene smaller Foraminifera in West Japan, the present microfauna corresponds to the lower part of his *Lagenonodosaria scalaris — Uvigerina crassicostata* zone; it also falls into his middle Miyoshian stage. Details of this time-rock unit and its correlation have been reported by the writer (Tai, 1959) under the title of "*Miocene Microbiostratigraphy of West Honshū, Japan*". In this publication, he concludes that the Miyoshian stage broadly corresponds to the Luisian stage established by R.M. Kleinpell (1938) in the California Miocene of North America. The Luisian stage is correlated with the Vindobonian age by that author.

Accordingly, it seems that the shale facies of the Bihoku group in the Funo and Saijō basins may belong to the Vindobonian age.

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